Vase Life of Cut Torch Ginger (*Etlingera elatior*) Inflorescences as Influenced by Stem Length

Rebekah Grace C. Choresca, Leizel B. Secretaria and Emma Ruth V. Bayogan*
College of Science and Mathematics
University of the Philippines Mindanao
Davao City, 8022 Philippines
*evbayogan@up.edu.ph

Date received: November 26, 2018
Revision accepted: April 1, 2019

Abstract

Effective postharvest handling techniques increase the vase life of tropical cut flowers and reduce flower loss. The effects of different stem lengths (35, 50, and 65 cm) soaked in distilled water or 200 mg L^{-1} 6-benzyladenine (BA) for 30 min on the visual quality, glossiness, days to additional browning of the bract, water uptake, vase life, and color (L - lightness, a* - red/green coordinate, b* - yellow/blue coordinate) of 75% mature cut torch ginger inflorescences were assessed. Results showed that water uptake decreased by the end of vase life at four to five days as did weight and a*. Regardless of stem length and BA, inflorescences exhibited gloss loss, reduction in L* b*, and increased bract browning resulting in less acceptable visual quality. At four days after treatment, samples with longer stem lengths (50 and 65 cm) showed slower gloss loss and higher water uptake than the short stemmed (35 cm) inflorescences. Under ambient conditions (26.81±0.31 °C and 71.47±4.64% RH), cut torch gingers with longer stems (65 cm) showed a vase life that was better than the control inflorescences by 18.7%. BA did not influence the postharvest quality and vase life of the inflorescences.*

***Keywords**:* stem length, torch ginger, water uptake, vase life

1. Introduction

Torch ginger (*Etlingera elatior*), a Zingiberaceae plant, is native to Malaysia and Indonesia (Choon *et al.*, 2016) and introduced in the Philippines (Smith, 1979). The solitary inflorescence of torch ginger is composed of a leafless peduncle and inflorescence head consisting of involucral and floral bracts (Choon and Ding, 2017). This tropical ornamental plant is characterized by its spectacular inflorescence, long flower stems, and waxy bright colored bracts (Unemoto *et al.*, 2011) that makes it a good addition in large tropical flower arrangements. It also has a good market value as it has become popular as an ornamental and landscaping plant in urban areas (Choon and Ding, 2016).

Handling of cut ornamentals demands proper postharvest management that could slow down quality deterioration and senescence (Vieira *et al*., 2014). Vase life in cut flowers is an indication of its shelf life which is an important target for ornamental quality maintenance (Amin, 2017). Stem length has been shown to affect vase life of bird-of-paradise (Bayogan *et al*., 2008) and ornamental ginger (Kobayashi *et al*., 2007) inflorescences. Preservatives such as BA, a cytokinin, effectively maintained goldenrod quality (Philosoph-Hadas *et al*., 1996) and extended the vase life of some tropical ornamentals depending on flower or inflorescence type, season of harvest and cultivar (Paull and Chantrachit, 2001).

This study evaluated the vase life and some postharvest characteristics (visual quality, color, glossiness, number of days before additional browning, water uptake, weight changes, and vase life) of torch gingers cut at three stem lengths pulsed in BA solution for 30 min.

2. Methodology

2.1 Preparation of Cut Torch Ginger Inflorescences

Newly harvested torch ginger inflorescences at 75% maturity (Figure 1) were purchased from a private farm in Tacunan, Davao City. The stems of the inflorescences were washed with tap water to eliminate dirt and bugs that may be present and then transported in clean pails with water to the Postharvest Biology Laboratory of the University of the Philippines Mindanao. The inflorescences were trimmed according to treatment and placed in individual bottles each with 300 mL distilled water. The exposed part of the mouth of the bottle was covered with cling wrap to minimize water loss due to evaporation.

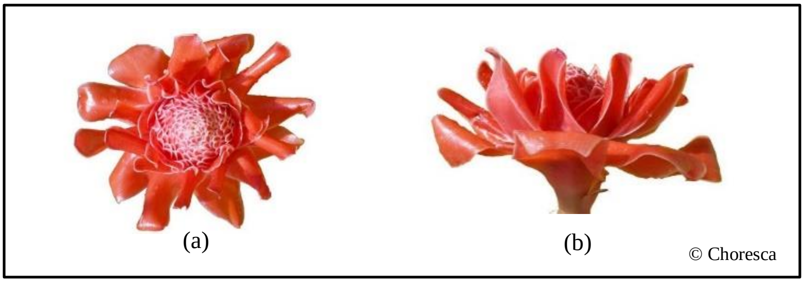

Figure 1. Top (a) and lateral (b) views of inflorescences at 75% harvest maturity

2.2 Different Stem Lengths and Pulsing with BA

The torch ginger stalk is topped by a cone-shaped inflorescence. Stem lengths were measured minus the cone-shaped inflorescence. The stems of 36 cut torch gingers were recut diagonally under water to three different lengths of 35, 50 and 65 cm; each with 12 inflorescences. From the 12 inflorescences, six were soaked in water as control while the remaining six were placed in bottles with 200 mg L^{-1} BA for 30 minutes. After dipping in BA, the inflorescences were transferred to bottles with 300 mL distilled water.

2.3 Data Gathered

The different parameters or indicators of the overall quality of cut flowers gathered were as follows: visual quality, color, glossiness, number of days before additional browning, water uptake, weight changes, and vase life. Freshness of a cut flower is dependent on external characteristics such as the visual quality, color, glossiness and browning of tissue. Further, the vase life is important in determining the period of acceptability of cut flowers while the weight changes and water uptake can influence the quality and vase life. Temperature and relative humidity of the Postharvest Biology Laboratory were recorded daily for the duration of the experiment using a HOBO® UX100-003 Temp/RH data logger. The experiment was conducted in ambient conditions (26.81±0.31°C and 71.47±4.64% relative humidity). Overall, visual quality was observed based on freshness, absence of gloss, discoloration and wilting (Figure 2). Glossiness as used by Paull and Chantrachit (2001) was adapted for torch ginger (Figure 3). Number of days before additional bract browning (Figure 4) was also evaluated. Color (L*, a*, b*) was measured on the first and seventh day of the experiment using a CR-400 Minolta chromameter. Luminosity or brightness (L*) corresponds to a dark-bright scale (0: black to 100: white), a* is negative for green, and positive for red, and b* is negative for blue and positive for yellow (Ayala-Silva *et al.*, 2005).

Water uptake was measured daily up to the end of vase life as the difference between the measured volume of the holding solution and the previous day's volume. Weight change was measured at the same time daily, up to the end of vase life as the difference between the measured weight of the cut inflorescence and the previous day's weight.

The vase life was measured from the start of the experiment to the time when the inflorescence reached a visual quality rating of 3 (Figure 2).

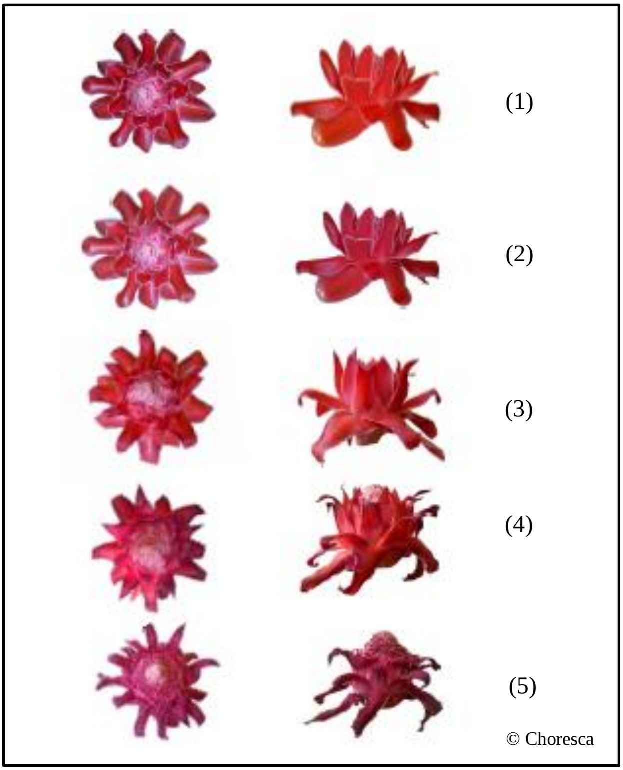

Figure 2. Visual quality rating used to evaluate the appearance of the inflorescences in top and lateral views: (1) excellent, field fresh and absence of discoloration; (2) good, few spots of brown; (3) fair, utmost 10% browning; (4) poor, about 20% browning; (5) very poor, over 20% browning (Bayogan and Gratuito, 2015)

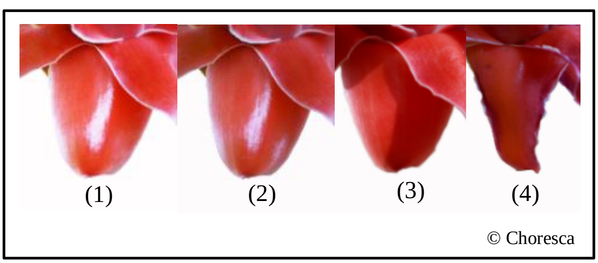

Figure 3. Glossiness rating: 1 – glossy; 2 – moderately glossy; 3 – moderate gloss loss; 4 – full gloss loss

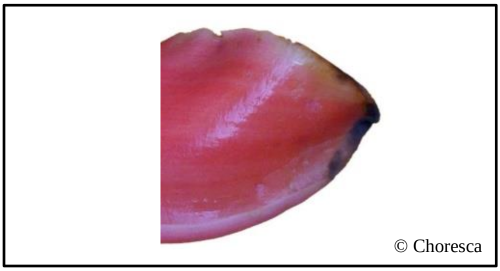

Figure 4. Browning of torch ginger bract

2.4 Experimental Design

The experiment had two factors (stem length and BA) arranged in a completely randomized design (CRD). There were six replications for each treatment, with each inflorescence serving as replication for a total of 36 samples. Data were analyzed using analysis of variance (ANOVA) and least significant difference (LSD) at $p \leq 0.05$ was used to compare treatment means.

3. Results and Discussion

3.1 Visual Quality

Even before harvest, the initial visual quality of the inflorescences was recorded starting at visual quality rating of 2 (Figure 2) as these had a few spots of brown in bracts located in the stem just below the inflorescence. Figures 5a and b show the visual quality as influenced by stem length and BA. The visual quality scores indicated increasing deterioration of inflorescence with holding in ambient conditions. Cut torch gingers of various stem lengths had similar visual quality.

Plant growth hormone like BA plays a significant role on cut flower vase life as it induces growth and development responses of plant, and stimulate cell division (Ramtin *et al*., 2016). In different anthurium cultivars, different responses to BA were observed and those greatly affected by BA had either a greater absorption capacity or had low tissue levels of cytokinins (Paull and Chantrachit, 2001). In the present study, however, BA at 200 mg L^{-1} did not influence the quality of the inflorescences.

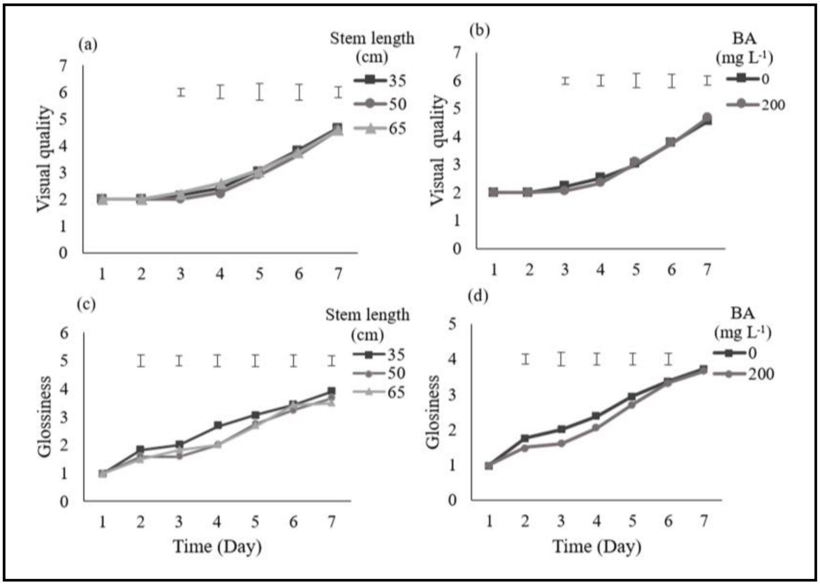

Figure 5. Visual quality (a and b) and glossiness (c and d) of cut torch ginger inflorescences as influenced by stem length and BA. Vertical bars indicate LSD values at $p \leq 0.05$.

In cut flowers, visual quality is an important criterion of postharvest management that influences the market value of products. It determines the physical and aesthetic acceptability of the produce. It is associated with freshness, bright color, glossiness, absence of discoloration and wilting, and good water uptake. In the present study, visual quality of inflorescence as affected by stem length and BA did not vary. This present findings is in contrast with the earlier results of Bayogan and Bajased (2017) where 200 mg/L BA improved the visual quality of torch ginger compared to untreated lot. The difference could be due to preharvest factors and practices. The torch gingers in this study were procured from a garden different from the source of inflorescences used in the earlier study.

3.2 Glossiness

For the first two days of holding, no significant difference in glossiness was observed among the cut torch gingers of varying stem lengths. On days three to four, samples with stem lengths of 50 and 65 cm had significantly lower gloss loss. Thus, in terms of glossiness, a longer stem length was deemed more acceptable than the 35 cm long inflorescences. Thereafter, no significant difference was found as all samples exhibited moderate to full gloss loss (Figures 5c and d). There was also no significant difference between the BA solution and water on the loss of gloss of the bracts of the cut torch gingers.

Glossiness is one of the characteristics that distinguish the waxy bracts of the inflorescence of torch ginger. The inability of cut flowers to draw water from the vase solution is associated with gloss loss, thus the gradual decrease of glossiness as they wilt (Reid, 2002).

3.3 Water Uptake

At the temperature and relative humidity conditions of the holding area, the initial water uptake of single 35 cm long inflorescences ranged from 15-35 mL; while that of the 50 and 65 cm inflorescences were 17-40 mL and 25-35 mL, respectively (Figure 6a). Water uptake of 65 cm cut torch gingers significantly differed from the 35 cm torch gingers on days three, four and six, but not with 50 cm cut torch ginger (except on day six). Water uptake of longer stemmed (65 cm) cut torch ginger was higher than all the other stem lengths on days three and four. The water uptake of 50 cm cut torch gingers was similar as the control except on day five. There was no increase in water uptake in cut torch gingers dipped in 200 mg L^{-1} BA (Figure 6b).

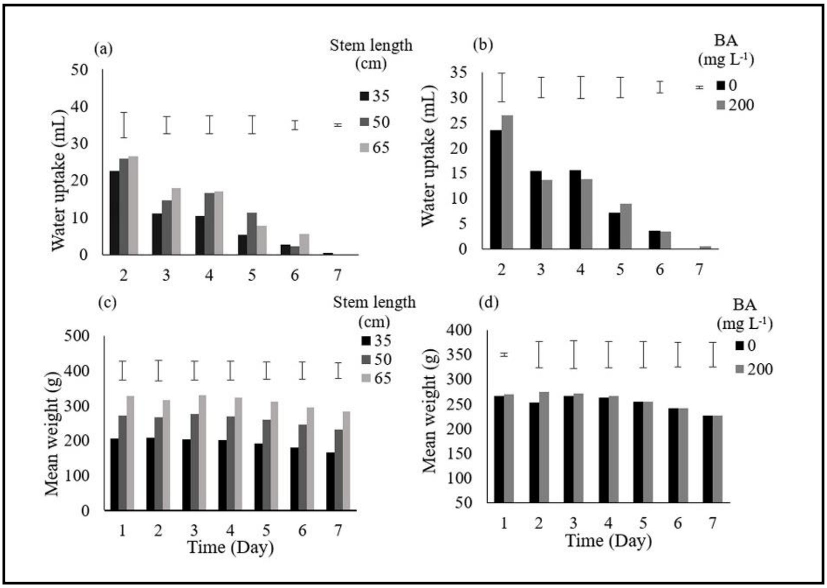

Figure 6. Daily water uptake (a and b) and mean weight (c and d) of cut torch ginger inflorescences as influenced by stem length and BA. Vertical bars indicate LSD values at $p \leq 0.05$.

The higher water uptake of long-stemmed torch ginger is in contrast with the result of Aswamanisa (2015) where the shortest torch ginger had the greatest water uptake. This difference may be influenced by the different inflorescence stages of cut torch ginger used in the experiment. Aswamanisa (2015) used two blooming stages (bud and opening) while inflorescences at 75% maturity stage (Figure 1) were used in the present study. Water uptake proportionately increases with maturity stage, indicative of the amount of water needed to maintain the turgidity of inflorescence (Bayogan and Gratuito, 2015).

Further, the variation in water uptake may be due to the differences in the area and solids content like carbohydrates with length of cut torch ginger. The greater area of xylem and more amount of carbohydrates may be responsible for higher uptake of water in a long stemmed inflorescence (Varu and Barad, 2010). The starch grains in torch ginger was reported to accumulate in the peduncle in which the amount decrease during the development of the inflorescence head (Choon and Ding, 2017). This indicates that there is more carbohydrate source in longer stemmed cut torch ginger as it has a greater peduncle area. In general, a reduction in water uptake can be observed from the first to the last in both treatments with or without BA. The decline of water uptake during the storage period is an indication that the tissue was not able to rehydrate due to irreversible damage caused by lack of cell hydration (da Costa *et al.*, 2017).

3.4 Weight Changes

Stems measuring 50 and 65 cm in length varied in weight starting from day one until the end of experiment (Figure 6c). All stem lengths differed from each other in weight by day four onwards. This can be due to the difference in water uptake the day before where 35 cm cut torch gingers had the lowest mean uptake. The initial weight of the 35 cm long inflorescences ranged from 125-320 g, while those with 50 cm and 65 cm stem lengths were 165-350 g and 225-430 g, respectively. Minimal weight change was observed in cut torch ginger with longer stem (65 cm). There was an average reduction of 15.47 g in weight among the cut inflorescences of different stem lengths at day seven. No significant differences were observed between the effects of BA application and the control on the changes in weight of the cut torch gingers from day one until the end of experiment (Figure 6d).

No direct relationship was observed between water uptake and weight change. The large surface area of the torch ginger inflorescence and temperature could have caused a higher transpiration rate relative to water uptake. Further, opposite results in water content and fresh weight of torch ginger during development was reported by Choon and Ding (2017). There was an increase of fresh weight while decrease in water content during the development of torch ginger from the tight bud to full bloom of the inflorescence.

3.5 Bract Color

The L* a* b* color space of the pink-colored torch ginger was measured. Brightness, L*, of all the cut torch gingers of various stem lengths treated with and without BA significantly decreased by the end of the experiment (Figure 7). Reduction in a* values were significant on day seven. Stems measuring 65 cm had the greatest decrease in a* values, indicating that the inflorescence became less red in color. On the other hand, 35 cm inflorescences had more pinkish red color as it approached a poor visual quality score of 5. All color values in torch ginger with BA decreased with time but this did not vary with the control.

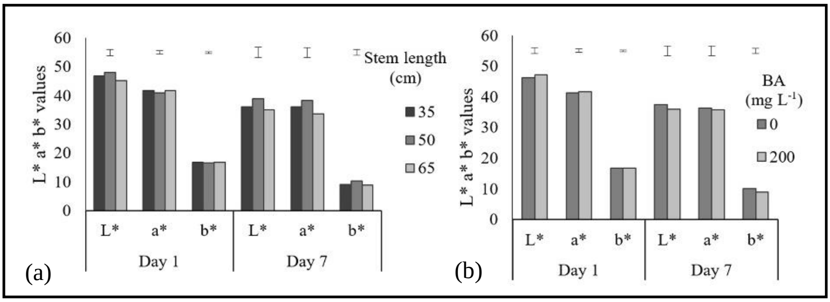

Figure 7. Initial and final L*, a*, b* values of cut torch ginger inflorescences of various stem lengths with (b) and without (a) 200 BA. Vertical bars indicate LSD values at $p \leq 0.05$.

Reduction of color in torch ginger indicate a decline in the intensity of color and brightness. This was observed as loss of glossiness, browning and wilting progressed during storage. Likewise, this was also observed in orchid inflorescences in which it became darker with less lively and intense color as storage time progressed (Mattiuz *et al.*, 2015). The discoloration of inflorescence indicated senescence which may be associated with water stress, decrease amount of carbohydrates and phenol oxidation (Reid, 2002; Mattiuz *et al.*, 2015).

3.6 Number of Days before the Appearance of Additional Browning

Few brown spots in the bracts below the inflorescences were evident even before harvest, so the number of days before additional browning was measured starting on day one. All torch gingers did not vary in the time for additional browning to manifest (Table 1).

Table 1. Number of days before additional browning and vase life of various stem lengths of cut torch ginger inflorescences treated with and without BA

Stem Length (cm)		BA (mg L^{-1})		Mean
		0	200	
		No. of days before additional browning[z]		
	35	3.3	3.8	3.6[a]
	50	4.0	4.0	4.0[a]
	65	3.3	3.5	3.4[a]
Mean		3.6[a]	3.8[a]	
		Vase life[z] (d)		
	35	4.0	4.5	4.3[a]
	50	4.3	4.8	4.6[ab]
	65	5.5	4.7	5.1[b]
Mean		4.6[a]	4.7[a]	

[z] means with common letters (column, row) are not significant at $p \leq 0.05$ using LSD

The number of days before appearance of additional browning in bracts was similar in different stem lengths as well as in BA treatments. Browning of torch ginger indicate the deterioration of quality leading to senescence of the inflorescence. The 65 cm long torch ginger had a longer vase life compared to the 35 cm long inflorescence. Similarly, longer stems increased the postharvest life of red ginger flowers (Kobayashi *et al.*, 2007), a species that belongs to the same family as torch ginger. The same observation was reported in mature inflorescences of bird-of-paradise (Bayogan *et al.*, 2008).

3.7 Vase Life

Vase life of various stem lengths between 35 and 65 cm varied in which 65 cm torch ginger displayed longer vase life compared to 35 cm long inflorescences (Table 1). Cut torch gingers with longer stem length (65 cm) showed an 18.7% longer vase life than the shorter stemmed samples (35 cm).

Both, however, showed no significant difference relative to the 50 cm cut torch gingers.

BA treatment through spraying or short dip of bold tropical flowers such as *Heliconia latispatha*, *Alpinia purpurata,* and *Strelitzia reginae* has been shown to extend the longevity of their postharvest vase life compared to control flowers (Jaroenkit and Paull, 2003; De Moraes *et al.*, 2005). Contrary to the above reports, the present results showed no variation on vase life between cut torch gingers with BA and the control. This may be because the duration of BA application in the present study was longer or that BA can also cause an increase of pH which is suitable for bacterial growth (Danaee *et al*., 2013). Bacterial growth has been shown to reduce the water uptake of cut flowers by blocking vessel systems and reducing vase life by production of toxic waste and ethylene (Vander Molen *et al.*, 1983; Zagory and Reid, 1986). Lower concentration of BA may be suitable to torch ginger as the vase life of another cut flower like Eustoma was extended significantly at a lower level at 25 and 50 mg L^{-1} (Asil and Karimi, 2010). The recommended temperature and relative humidity for storage of torch gingers are 15-18 °C and 90-95% (Vieira *et al.*, 2014), respectively. However, in the present study, the temperature was higher at 26.65-26.96 °C while relative humidity was lower (69.15-73.79%) than the recommended storage conditions. Warm temperature has been correlated with increases in respiration rate (Çelikel *et al.*, 2002), causing rapid wilting of cut flowers and gloss loss.

4. Conclusion

The effects of three stem lengths and pulsing with BA on the longevity of torch gingers, based on visual quality, days to additional browning of bracts, glossiness, water uptake, weight changes and color (L*, a*, b*) were evaluated. The inflorescences were held under ambient conditions (26.81±0.31 °C and 71.47±4.64% RH). On the fourth day, 50 and 65 cm long inflorescences had lower gloss loss and greater water uptake. The stem length was proportional to the inflorescence weight that decreased with time. Visual quality, days to additional browning of bracts and color (except a* on day seven) of the various stem lengths were similar. Likewise, BA did not affect all the parameters that were evaluated in contrast with earlier results from inflorescences sourced from a different garden. Torch gingers that were 65 cm long exhibited a vase life that was a day longer or 18.7% better than the control inflorescences.

5. References

Amin, O.A. (2017). Effect of some chemical treatments on keeping quality and vase life of cut chrysanthemum flowers. Middle East Journal of Agricultural Research, 6(1), 208-220.

Asil, M.H., & Karimi, M. (2010). Efficiency of benzyladenine reduced ethylene production and extended vase life of cut *Eustoma* flowers. Plant Omics Journal, 3(6), 199-203.

Aswamanisa, A. (2015). Effects of peduncle length on vase life of cut torch ginger inflorescence (*Etlingera elatior*) (Project Paper Report). Retrieved from http://webcache.googleusercontent.com/search?q=cache:wFB7JZl_9VQJ:psasir.upm.edu.my/id/eprint/65538+&cd=2&hl=en&ct=clnk&gl=ph.

Ayala-Silva, T.A., Schnell II, R.J., Meerow, A.W., Winterstein, M.C., Cervantes-Martinez, C., & Brown, J.S. (2005). Determination of color and fruit traits of half-sib families of mango (*Mangifera indica* L.). Proceedings of the Florida State Horticultural Society, 118, 253-257.

Bayogan, E.V., & Bajade, V.K.H. (2017). Vase life and quality of torch ginger (*Etlingera elatior*) inflorescences treated with 6-benzyladenine. Acta Horticulturae, 1179, 165-172. https://doi.org/10.17660/ActaHortic.2017.1179.25.

Bayogan, E.V., & Gratuito, M.B.B. (2015). Vase life of torch ginger (*Etlingera elatior*) inflorescences as influenced by harvest maturity and 1-methylcyclopropene. Acta Horticulturae, 1088, 313-317. https://doi.org/10.17660/ActaHortic. 2015.1088.52.

Bayogan, E.V., Jaroenkit, T., & Paull, R.E. (2008). Postharvest life of bird-of-paradise inflorescences. Postharvest Biology and Technology, 48(2), 259-263. https://doi.org/10.1016/j.postharvbio.2007.10.010.

Çelikel, F.G., Dodge, L.L., & Reid, M.S. (2002). Efficacy of 1-MCP (1-methylcyclopropene) and Promalin for extending the post-harvest life of oriental lilies (Lilium x 'Mona Lisa' and 'Stargazer'). Scientia Horticulturae, 93, 149-155.

Choon, S.Y., & Ding, P. (2016). Growth stages of torch ginger (*Etlingera elatior*) plant. Sains Malaysiana, 45(4), 507-515.

Choon, S. Y., Ding, P., Mahmud, T. M. M., & Shaari, K. (2016). Phenological growth stages of torch ginger (*Etlingera elatior*) inflorescence. Pertanika Journal of Tropical Agriculture Science, 39 (1), 73-78.

Choon, S.Y., & Ding, P. (2017). Developmental changes in cellular structure and cell wall metabolism of torch ginger (*Etlingera elatior* (Jack) R.M. Smith) inflorescence. Current Plant Biology, 9-10, 3-10.

da Costa, L.C., de Araújo, F.F., de Sousa Santos, M.N., Lima, P.C.C., Pereira, A.M., & Finger, F.L. (2007). Vase life and rehydration capacity of dry-stored gladiolus flowers at low temperature. Ciência Rural, 47, 1-6. http://dx.doi.org/10.1590/0103-8478cr20160139

Danaee, E., Naderi, R., Kalatejari, S., & Moghadam, A.R.L. (2013). The effects of benzyladenine as a preservative on the stem bending of gerbera cut flowers. International Research Journal of Applied and Basic Sciences, 4(9), 2649-2651.

De Moraes, P.J., Finger, F.L., Barbosa, J.G., Cecon, P.R., & Cesa, L.P. (2005). Influence of benzyladenine on longevity of *Heliconia latispatha* Benth. Acta Horticulturae, 683, 369-374. https://doi.org/10.17660/ActaHortic.2005.683.47

Jaroenkit, T., & Paull, R.E. (2003): Postharvest handling of *Heliconia*, red ginger and bird-of-paradise. HortTechnology, 13(2), 259-266.

Kobayashi, K.D., McEwen, J., & Kaufman, A.J. (2007). Ornamental ginger, red and pink. Cooperative Extension Office, University of Hawaii, Manoa, Hawaii. Retrieved from http://www.ctahr.hawaii.edu/oc/freepubs/pdf/OF-37.pdf

Mattiuz, C.M., Mattiuz, B.H., Rodrigues, T.D., Marques, K.M., & Martins, R.M. (2015). Effectiveness of postharvest solutions for the conservation of cut *Oncidium varicosum* (Orchidaceae) inflorescences. Ciência e Agrotecnologia, 39 (4), 315-322.

Paull, R.E., & Chantrachit, T. (2001). Benzyladenine and the vase life of tropical ornamentals. Postharvest Biology and Technology, 21(3), 303-310. https://doi.org/10.1016/S0925-5214(00)00153-8

Philosoph-Hadas, S., Michaeli, R., Reuveni, Y., & Meir, S. (1996). Benzyladenine pulsing retards leaf yellowing and improves quality of goldenrod (*Solidago canadensis*) cut flowers. Postharvest Biology and Technology, 9, 65-73. https://doi.org/10.1016/0925-5214(96)00023-3

Ramtin, A., Kalatejari, S., Naderi R., & Matinizadeh, M. (2016). Effect of benzyladenine and salicylic acid on biochemical traits of two cultivars of carnation. Journal of Experimental Biology and Agricultural Sciences, 4(4), 427-434.

Reid, M.S. (2002). Cut Flowers and Greens. Department of Environmental Horticulture. University of California, Davis, CA. Retrieved from https://www.researchgate.net/publication/252719032_Cut_Flowers_and_Greens.

Smith, A.C. (1979). Flora Vitiensis nova: a new flora of Fiji. National Tropical Botanical Garden. Retrieved from http://www.ntbg.org/plants/plant_details.php?plantid=4977#.

Unemoto, L.K., de Faria, R.T., Takahashi, L.S.A., de Assis, A.M., & Lone, A.B. (2011). Longevity of torch ginger inflorescences with 1-methylcyclopropene and preservative solutions. Acta Scientiarum. Agronomy, 33(4), 649-653. http://dx.doi.org/10.4025/actasciagron.v33i4.11084.

Varu, D. K., & Barad, A.V. (2010). Effect of stem length and stage of harvest on vase-life of cut flowers in tuberose (*Polianthes tuberosa* L.) cv. Double. Journal of Horticultural Sciences, 5(1), 42-47.

Vander Molen, G.E., Labavitch, J.M., Strand, L.L., & De Vay, J.E. (1983). Pathogen induced vascular gels: ethylene as a host intermediate. Physiologia Plantarum, 59(4), 573-580. https://doi.org/10.1111/j.1399-3054.1983.tb06282.x.

Vieira, M.S., Simōes, A.N., & Souza, P.A. (2014). Recommended temperature and relative humidity for storage of Brazilian tropical flowers. African Journal Biotechnology, 13(11), 1198-1201. http://dx.doi.org/10.5897/AJBX2013.13427.

Zagory, D., & Reid, M.S. (1986). Evaluation of the role of vase microorganisms in the postharvest life of cut flowers. Acta Horticulturae, 181, 207-218. https://doi.org/10.17660/ActaHortic.1986.181.25.